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(54) **Combustion additive for diesel
fuel oil comprising Ca and Fe salts**

(57) The combustion of a diesel fuel
oil is improved by an additive
comprised of an oil soluble or
dispersible calcium compound and an

oil soluble or dispersible iron
compound. Such improved
combustion is evidenced by improved
fuel mileage and/or improved smoke
suppression and/or improved engine
cleanliness and/or improved engine
efficiency.

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SPECIFICATION

Combustion additive for diesel fuel oil

This invention relates to improving the combustion of a fuel oil in engines.

5 Diesel fuel oils are currently employed for the propulsion of vehicles; in particular, automotive vehicles (cars and trucks) railroad engines, and ships. As a result of the current energy problems, there is a need to improve the combustion efficiency of such fuels. 5

In accordance with one aspect of the present invention, there is provided a combustion improving additive for a diesel fuel oil employed for the propulsion of vehicles and ships which is comprised of an oil soluble or dispersible calcium compound and an oil soluble or dispersible iron compound in an amount effective to improve the combustion of a diesel fuel oil. 10

In accordance with another aspect of the present invention, there is provided an improved fuel which is a diesel fuel oil for the propulsion of vehicles or ships having calcium and iron dissolved or dispersed therein in an amount effective to improve the combustion efficiency of such diesel fuel oil.

15 The fuel oil soluble or dispersible calcium compound may be any one of a wide variety of compounds which are soluble or dispersible in the diesel fuel oil. As representative examples of suitable organic and inorganic calcium compounds which are soluble or dispersible in the diesel fuel oil, there may be mentioned: 15

20 Calcium Sulfonate
Calcium Naphthenate
Calcium Carboxylate
Calcium Carbonate
Calcium Hydroxide 20

The fuel oil soluble or dispersible iron compound may be any one of a wide variety of compounds which are soluble or dispersible in the diesel fuel oil. As representative examples of suitable organic and inorganic iron compounds which are soluble or dispersible in the diesel fuel oil, there may be mentioned: 25

Iron Naphthenate
Ferrocene
Iron Oxide

30 The selection of a combination of oil soluble or dispersible calcium and iron compounds for a particular diesel fuel oil is deemed to be within the scope of those skilled in the art from the teachings herein. The preferred combination is represented by calcium sulfonate and iron naphthenate. 30

Applicant has found that the use of a combination of the iron and calcium compound provides an unexpected improvement in combustion efficiency of a diesel fuel oil employed for the propulsion of vehicles, or ships which could not be achieved by using one of the compounds in the absence of the other. Such improved combustion efficiency is evidenced by improved fuel mileage and/or improved engine cleanliness and/or improved smoke suppression and/or improved engine efficiency. 35

The fuel additive includes the iron and calcium compounds in effective combustion improving amounts. In general, the ratio of calcium to iron is from 0.01:1 to 100:1, and preferably 1:1 to 10:1 (weight basis). The selection of an optimum ratio for any particular application is deemed to be within the scope of those skilled in the art from the teachings herein. 40

The fuel additive is preferably employed as a liquid additive comprised of the iron and calcium compound dissolved in an oil which is soluble in the diesel fuel oil. Any one of a wide variety of oils may be employed, and as representative examples of such oils there may be mentioned: light diesel oil, process oils, naphthenic oils. 45

45 Applicant has found that the use of such additives improves the combustion efficiency of the diesel fuel oil as evidenced by reduced smoke emission and/or increased fuel mileage and/or improved engine cleanliness (reduced engine deposits) and/or improved engine efficiency. In addition, the iron and calcium combustion product (iron and calcium oxide) are relatively innocuous in the engine exhaust. As a result, improved combustion is obtained with the use of an additive which will not adversely affect the environment. 50

The additive is added to the diesel fuel oil to provide a combustion improvement amount of iron and calcium dissolved or dispersed in the diesel fuel oil. In general, improved combustion efficiency is obtained by employing at least 5 ppm of the iron and at least 5 ppm of the calcium in the diesel fuel oil (weight basis). In most cases, the calcium and iron are employed in amounts of at least 50 ppm and at least 5 ppm, respectively. The calcium and iron are generally not added in an amount in excess of 100 ppm and 100 ppm, respectively, in that no added beneficial effect is obtained by increasing the amount of additive. The selection of optimum amounts of the additive is deemed to be within the scope of those skilled in the art from the teachings herein. 55

The additive may also include other components which may be normally added to a diesel fuel oil. As representative examples of such materials, there may be mentioned: dispersants and emulsifiers. 60

Although the additive may be employed for any one of a wide variety of diesel fuel oils, the additive is particularly suited for a light diesel fuel oil for high speed engines (operating at over 550 rpm), such as in an automotive or railroad engine.

The present invention will be further described with respect to the following examples; however,

the scope of the invention is not to be limited thereby:

EXAMPLE 1

A mixture was prepared by blending an oil soluble calcium compound (calcium sulfonate) and an oil soluble iron compound (iron naphthenate) at a weight ratio of 8:1 respectively. The mixture was diluted with diesel oil to produce an additive containing 4.8% calcium and 0.6% iron. The additive was submitted to an independent research laboratory for smoke suppression testing. The format of the evaluation follows:

1. The testing was performed with a Caterpillar 1Y73 test engine. The base fuel was Howell hydrocarbons Cat 1—G2. A Bosch ΣFAW-68A Smoke Meter was used to measure smoke density.
2. *Two hour run on base fuel (Cat 1-G2)* — All engine operating conditions were maintained with continuous monitoring of engine exhaust smoke to establish a base line smoke level.
3. *Two hour run on base fuel + additive blended at 600:1* — (1 part of additive to 600 parts of base fuel by volume). With all engine operating conditions maintained constant as with the base fuel run, the fuel was switched to a 600:1 blend. Engine exhaust smoke continuously monitored.
4. *Two hour run on base fuel + additive blended at 400:1* — (1 part of additive to 400 parts of base fuel by volume). With all engine operating conditions maintained constant as with the base fuel run, the fuel was switched to a 400:1 blend. Engine exhaust smoke was continuously monitored.

Measured Exhaust Smoke Levels

Measurement	Run No. 1 Base Fuel	Run No. 2 Base 600:1	+ Run No. 3 Additive 400:1
1	2.4		1.6
2	2.4	1.7	1.7
3	2.4	1.6	1.7
4	2.3	1.4	1.5
5	2.4	1.6	1.5
6	2.4	1.6	1.7
7	2.3	1.9	
8	2.6	1.6	
9	2.4	1.5	1.5
10	2.5	1.5	1.6
	$\bar{x} = 2.41$	$\bar{x} = 1.60$	$\bar{x} = 1.60$
	$\Sigma = 0.088$	$\Sigma = 0.141$	$\Sigma = 0.093$

The data indicate a 34% reduction in the smoke level using the additive.

EXAMPLE 2

An additive was prepared by blending an oil soluble calcium compound and an oil soluble iron compound in diesel oil as in Example 1. The additive contained 4.8% calcium and 0.6% iron by weight. The additive was evaluated on a fleet of trucks at a dosage rate of 1 part additive to 1000 parts fuel by volume. The additive was evaluated for a total of 15 consecutive months. The truck engines were Cummins 270 and Cummins 290. Mileage per gallon of fuel consumed data were recorded on a daily basis. An average of 4.3% improvement in mileage per gallon of fuel consumed was recorded.

Additionally, after 12 months of additive use, one truck was taken out-of-service and the engine overhauled and inspected. There were not any deposits on the internals of the engine.

EXAMPLE 3

An additive was prepared by blending an oil soluble calcium compound and an oil soluble iron compound in diesel oil as in Example 1. The additive contained 4.8% calcium and 0.6% iron by weight. The additive was evaluated on a fleet of trucks at a dosage rate of 1 part additive to 1000 parts fuel by

volume. The additive was evaluated for 10 consecutive months. Mileage per gallon of fuel consumed data were recorded for each trip. The truck engines were Caterpillar 325. An average of 11.0% improvement in mileage per gallon of fuel consumed was recorded.

- 5 Numerous modifications and variations of the present invention are possible in light of the above teachings and, therefore, within the scope of the appended claims, the invention may be practised otherwise than as particularly described. 5

CLAIMS

1. A combustion improving additive for a diesel fuel oil employed for the propulsion of vehicles, and ships comprising: 10
- (a) an oil soluble or dispersible calcium compound; and
- (b) an oil soluble or dispersible iron compound, said (a) and (b) being present in an amount effective to improve the combustion of a diesel fuel oil. 10
2. The additive of Claim 1 wherein the weight ratio of calcium compound to iron compound is from 0.01:1 to 100:1. 15
3. The additive of Claim 1 or 2 wherein said weight ratio is from 1:1 to 10:1. 15
4. The additive of any one of the preceding claims wherein the calcium compound is calcium sulfonate. 15
5. The additive of any one of the preceding claims wherein the iron compound is iron naphthenate. 15
6. The additive of any one of the preceding claims wherein the additive is a liquid additive and said calcium and iron compounds are dissolved in an oil which is soluble in the diesel fuel oil. 20
7. A process for improving the combustion of a diesel fuel oil which comprises adding a combustion improving additive of any one of the preceding claims to the diesel fuel oil. 20
8. A diesel fuel oil containing an additive according to any one of Claims 1 through 6. 20